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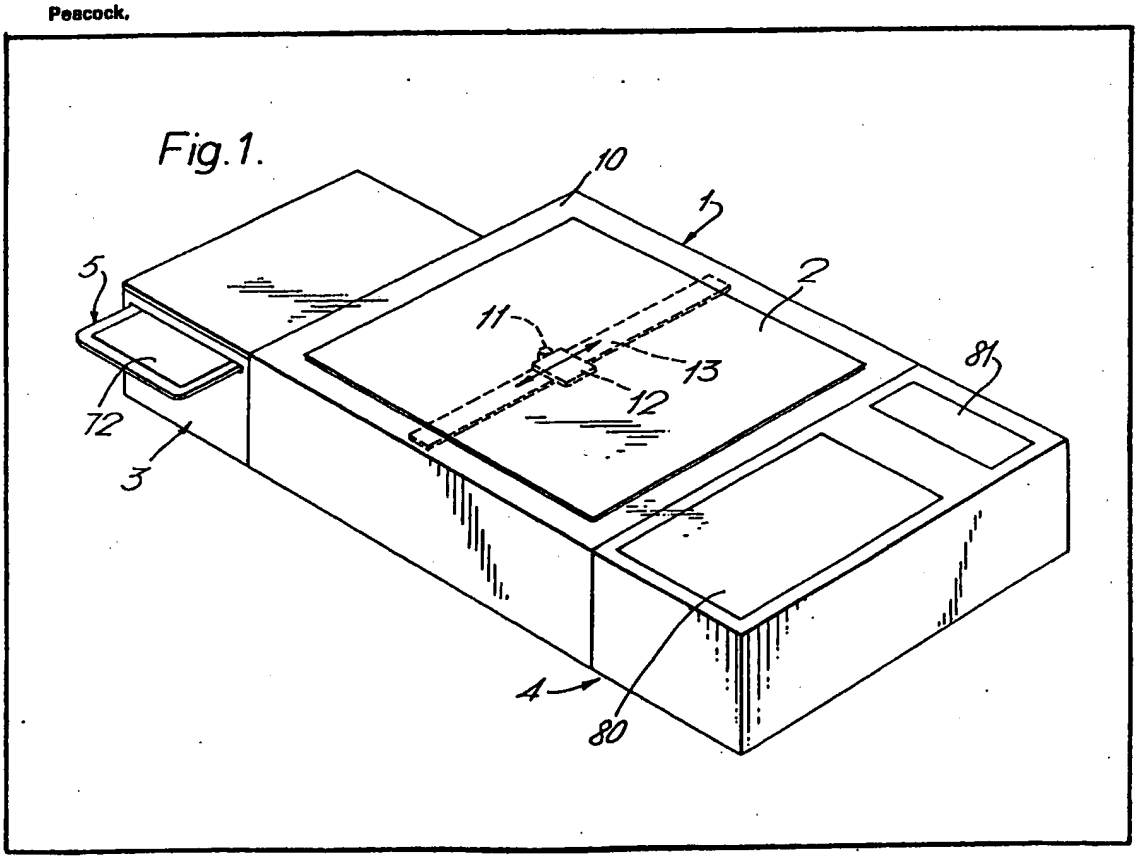
(54) Chart Plotting System

(57) A nautical chart plotting system comprising a marker light 11 moving under a chart 2, and operating in accordance with signals from a ship's log and compass, has a card reader unit 3 which receives a magnetic card 5 bearing information such as chart scale and projection, tidal flow, speed and direction of current, initialization co-ordinates, hazards and so on, which is used for subsequent processing and correction of the ship's position as derived from the log and compass.



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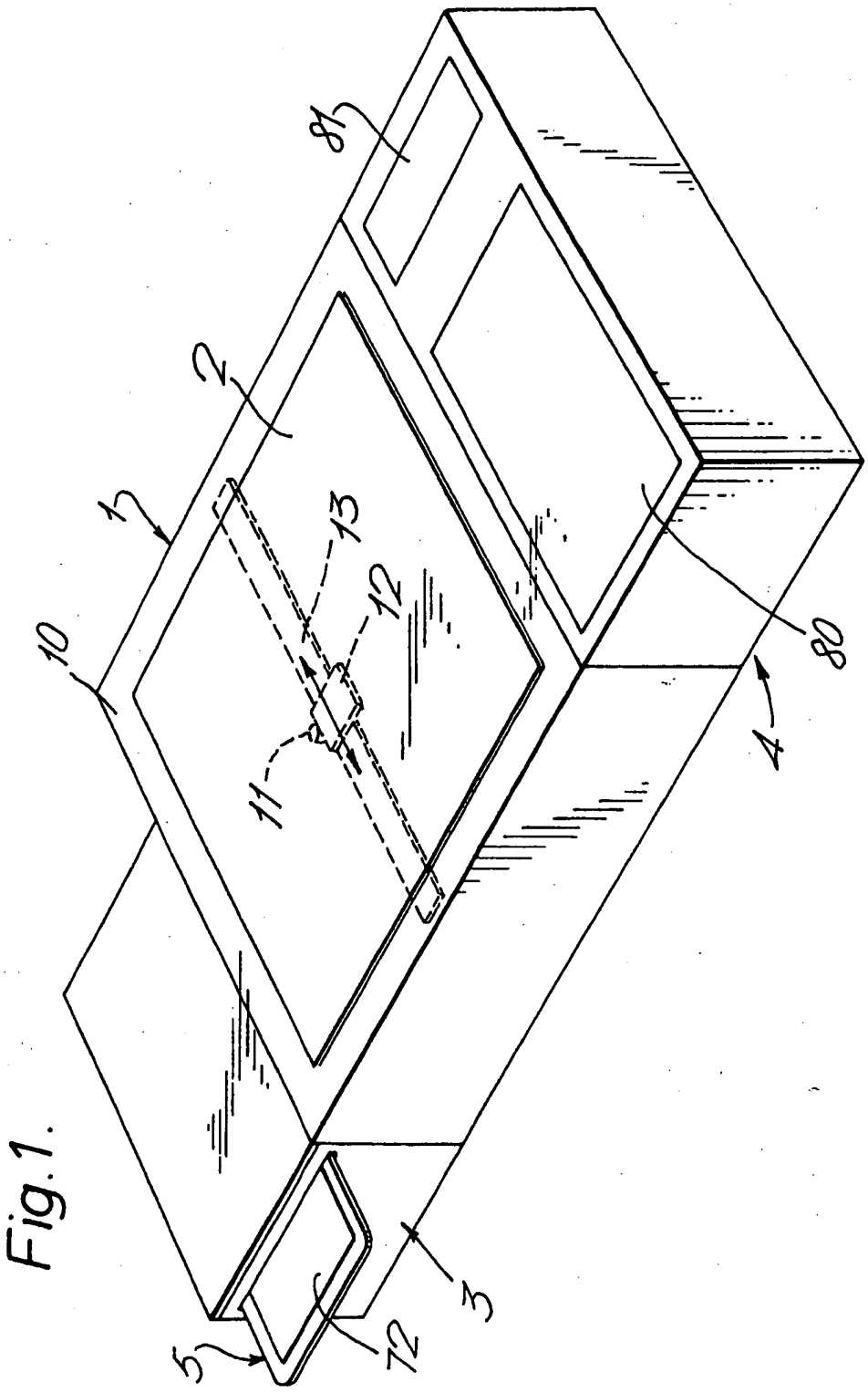

Fig.1.

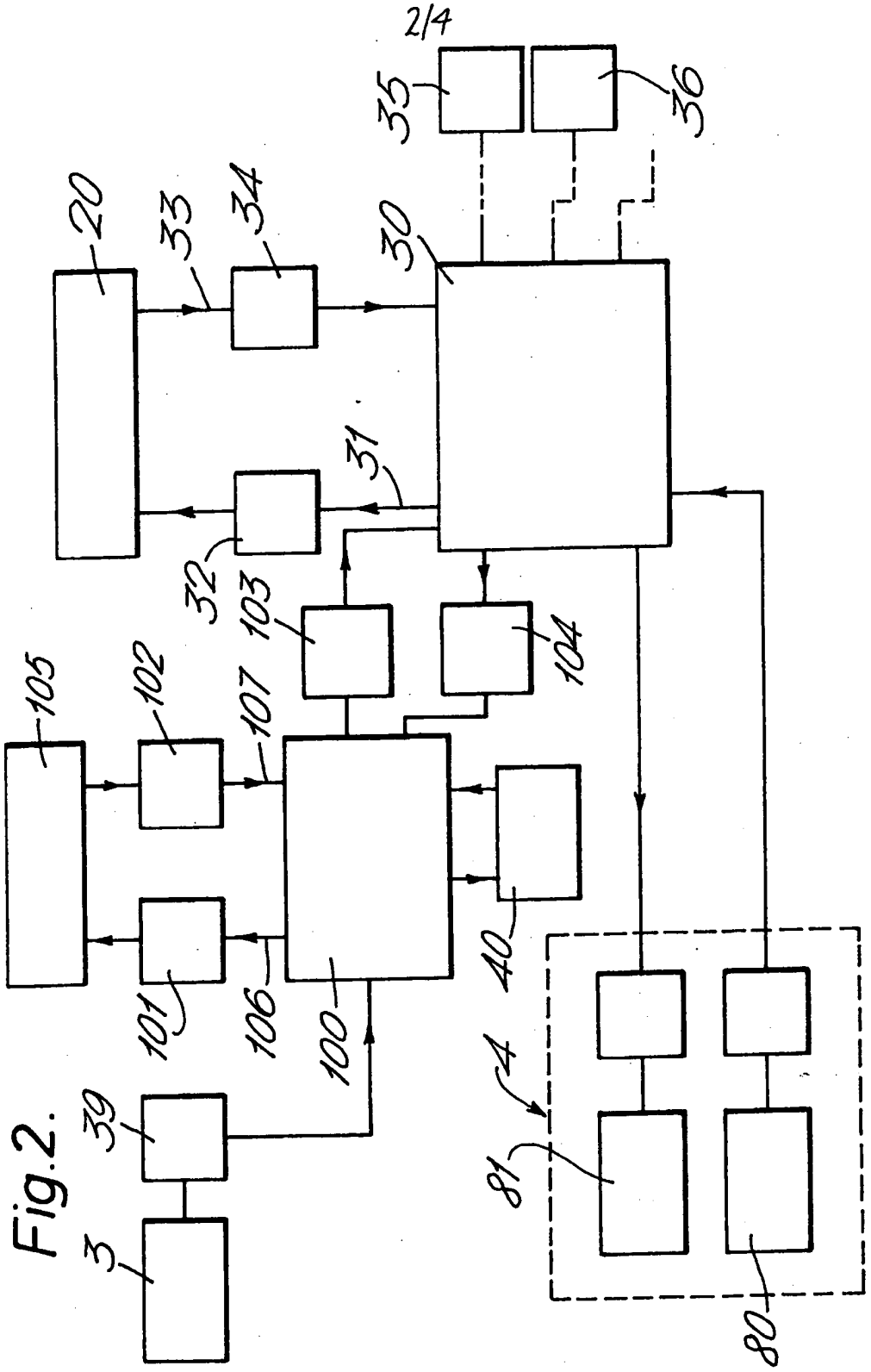
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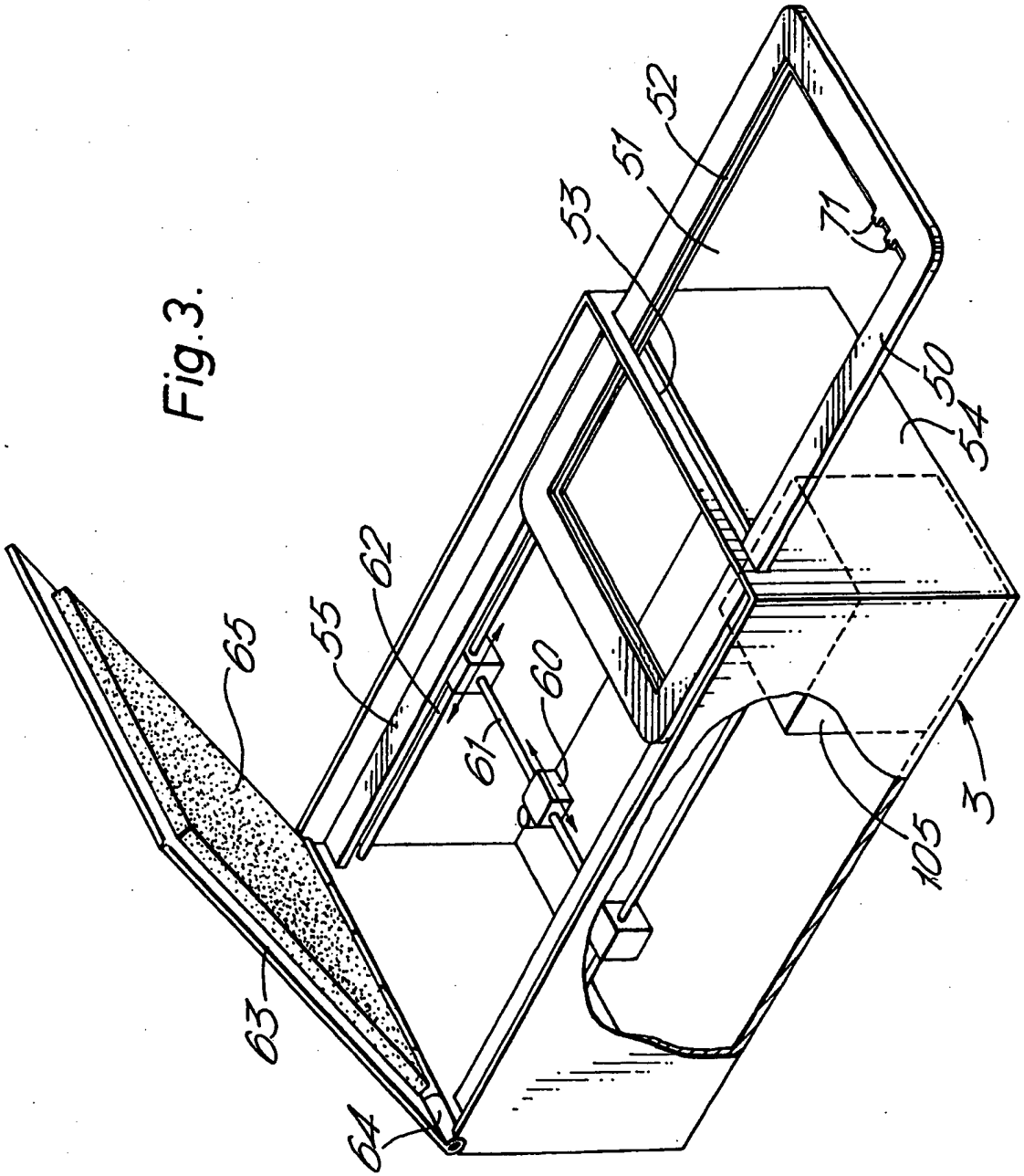
Fig.2.

Fig.3.



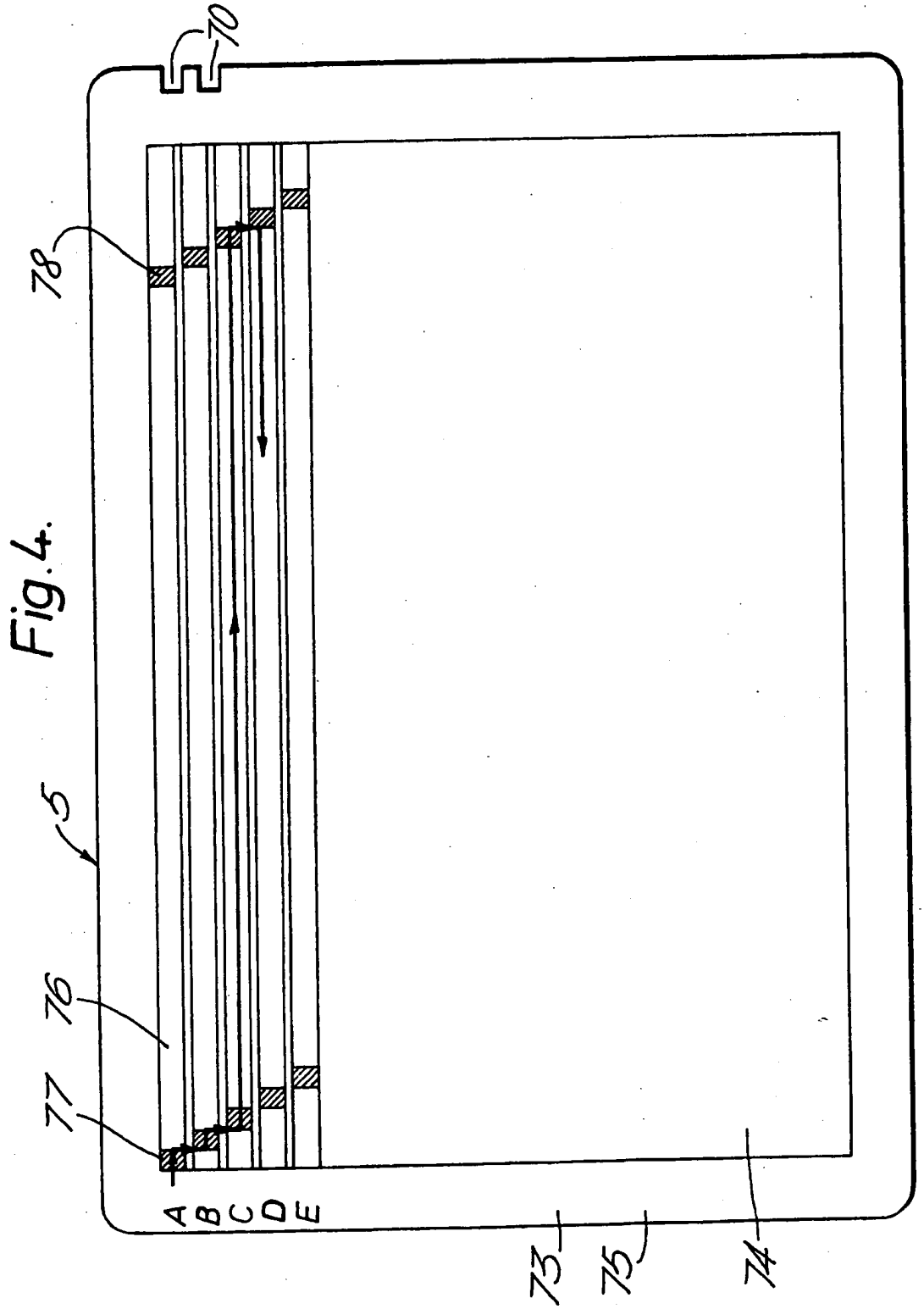


Fig.4.

SPECIFICATION

Chart Plott rs

This invention relates to chart pl tters. The invention is more particularly concerned with chart plotters for nautical use in which the location of the craft carrying the chart plotter is indicated by the position of a marker that is moveable across the chart surface.

Chart plotters are in widespread use in larger ships for navigational purposes, producing a continuous representation of the location of the ship. Chart plotters of this kind have a flat bed on which a chart of the relevant area is laid. The marker may be in the form of light source that is moved under the chart, or may be provided by intersecting cursors moved above the chart. In operation, the plotter receives information from the ship's navigational instruments such as its log, compass, radio and satellite navigational instruments, or any inertial guidance systems. This information is utilised by the plotter appropriately to drive the marker with respect to the chart.

Prior to operation, information about the chart is entered into the plotter by the operator, such as by means of a keyboard or other manually-actuable means. This information typically concerns the initialization points for the chart (that is, the reference points on the chart used for correlating the chart and plotter coordinates at the start of the operation) and the projection of that chart. Information about the initial location of the ship is also entered; this may be carried out by manually moving the marker to the present location of the ship and then starting operation of the plotter.

Such chart plotters can function fairly accurately when absolute information about the location of the ship is available such as from satellite navigation instruments. Difficulties arise, however, when navigation is performed from information that is derived solely from the compass and log, that is, by using dead reckoning. This is because, whilst the heading and speed relative to the water can be determined fairly accurately, the actual track of the ship will be affected by the movement of the water such as caused by currents and tidal flow. To compensate for this it has been necessary to perform various calculations and enter manually information concerning tides and currents so that the plotter can compensate appropriately for these factors.

The current and tidal information can be especially lengthy, but even without such information the initial setting of the chart can be a laborious and time-consuming task. On a typical v yage it may be necessary to us nine or m re charts, the large scale charts used for inshore navigation having to be changed v ry frequently. Errors produced in entering information about the chart will lead to errors in the positioning of the mark r and may thereby cause th ship to take a wrong course with the consequent dangers that might arise.

Further difficulties arise because th utilization procedure requires at least thr e sets of latitude and longitude coordinates t b entered for each chart. Also, d tails of the projection of the chart need to be entered. Manually entering this information is time consuming and liable to error.

Another difficulty occurs when the spheroid on which the chart is based differs from the spheroid used for the plotting table calculations. At present, this is corrected on some tables by manually entering shifts.

Obviously, the more detailed the information that is entered in the plotter about the chart and the area covered by the chart, the more accurate can be the representation of the location of the ship.

It is an object of the present invention to provide means for enabling the above-mentioned disadvantages substantially to be alleviated.

According to the present invention there is provided a chart plotting system including marker means that is moveable relative to a chart such as to represent location, wherein the said plotting means includes reader means that is arranged to read information represented in machine-readable form concerning said chart, and, or alternatively, the region represented by said chart, such that operation of said system is dependent on said information.

The reader means may be arranged to read information that is magnetically encoded and the information may be carried by a data-storage member, separate from the chart, of card shape.

The data-storage member may have a plurality of substantially parallel elongate tracks containing information in machine-readable form, each of some at least of said tracks including a portion containing information regarding the contents of the remainder of said track, said portions being located at the start of information in said respective tracks, and each said portion being displaced along the length of its respective track relative to an adjacent one of said portions in the direction of reading of said tracks such that said portions can be read one after the other by changing tracks and without displacement parallel to the tracks in the opposite direction.

A chart plotting system, in accordance with the present invention, will now be described, by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a schematic perspective view of the entire system;

Figure 2 illustrates the system in greater detail;

Figure 3 shows a part of the system in greater detail; and

Figure 4 shows a data-storage member for use in the plotting system.

With reference to Figure 1, the chart pl tting system is mounted in a ship (not shown) and compris s a plotting table 1, on which a chart 2 is laid, a card reader unit 3, and a c ntrol unit 4. Information about the chart 2 is entered by m ans of magnetic cards 5 that are read by the reader unit 3.

The plotting table may be of the servo-controlled kind, such as described in the specification of U.K. Patent Application GB 2 022 843A, or of any other suitable kind. The table 1 has a flat bed 10 with a transparent surface on which the chart 2 is placed and fastened securely in position. A light source 11 is mounted underneath the bed 10 on a carriage 12 that is slidable along the length of a transverse arm 13. The transverse arm 13 is mounted at its ends for displacement at right angles to its length in a plane parallel to the bed 10. The light source 11 is arranged to project a spot of light vertically upwards onto the back of the chart 2, so as to be visible from above, and may be provided with cross-wires or other reticle such as to facilitate accurate reading. By moving the carriage 12 along the arm 13, and by moving the arm at right angles to its length, the light source 11 can be positioned anywhere under the chart 2.

With reference now to Figure 2, the plotting table 1 has a drive unit 20 for displacing the carriage 12 and arm 13. This may include rotary or linear electric motors coupled through gears or a flexible drive and is controlled by signals from a processing unit 30 along line 31 via an interface unit 32. Servo signals return to the processing unit 30 via line 33 and an interface unit 34.

The processing unit 30 also receives input signals from the ship's log 35, representative of the speed of the ship relative to the water, and from the ship's gyro or magnetic compass 36, representative of the heading of the ship. From these signals the processing unit computes by dead reckoning the output signals used to move the marker across the plotting table 1.

Calculations of the ship's position derived by dead reckoning are corrected in accordance with the data supplied to the processing unit and program store 100 from the card reader 3 via an interface unit 39. The card reader 3 reads into a RAM store 40 information contained on cards 5 which is of the following kind:—

1. Tidal Diamond Data. Tidal diamonds are marks on charts which give information on tidal flow at a particular location. Each diamond is given an identification letter which enables the direction and speed of the flow to be obtained, at various times relative to high water, by consulting a table printed on the chart. The time of high water is normally obtained from standard tide tables.
2. Current data. Information about the direction and speed of both local and ocean currents at various positions on the chart.
3. Chart Data. Initialization coordinates and information about the projection and spheroid used in making the chart. The cards 5 also carry an identification code for checking that the correct card is used with the correct chart.
4. Other Data. The cards 5 may also carry other information, such as details about radio navigation beacons, lighthouses or hazards. Information of a confidential or secret nature, such as for fishing, geological prospecting or military applications could also be carried. In this way, a chart could be distributed publicly whereas cards bearing confidential information could be distributed only to those authorised to receive them.

The processing unit 100 addresses the appropriate locations in the store 40 in accordance with the calculated location of the ship thereby to derive information about the currents and tidal flow or other information associated with that region. This information is used in the dead reckoning calculations to produce a better estimate of the location of the ship.

The processing unit and program store 100 will also directly convert the position, in latitude and longitude, on the spheroid of the chart to the position, in latitude and longitude, on the spheroid used in the plotting table calculations. The processing unit and program store 100 also functions in the opposite manner, that is, to convert plotting table coordinates into chart coordinates.

Information from the processing unit 30 is supplied to the processing unit and program store 100, via an interface 104, which returns information to the processing unit 30 via an interface 103.

The card reader unit 3, will now be described in greater detail with reference to Figure 3. The reader 3 has a tray 50 with a rectangular central aperture 51 defined by a ledge 52 on which the card 5 is supported around its edge. The tray 50 is slidable along its length through a slot 53 in the upper part of the main housing 54 of the reader 3, the tray being supported at opposite sides by narrow shelves 55. A magnetic reading head 60 is mounted beneath the shelves 55 for reading a magnetically encoded side of the card 5. The head 60 is of conventional form and is mounted for movement along the length of a transverse arm 61 under control of the drive unit 105 (Figure 2). The transverse arm 61 is itself mounted at its ends on longitudinal rails 62, and can be moved at right angles to its length by the drive unit 105. By appropriately displacing the head 60 along the arm 61, and the arm along the rails 62 the head can be moved to any point on the surface of the card 5. A top plate 63 is hinged along one edge 64 at the top of the reader 3. The plate 63 carries on its under surface resilient padding 65 or a sprung pressure pad which, when the plate is in its closed position, bears against the upper surface of card 5 to urge it firmly against the tray 50.

The drive unit 105 may include rotary or linear electric motors coupled through gears or a flexible drive and is controlled by signals from the processing unit and program store 100 along line 106 via an interface unit 101. Servo signals return to the processing unit and program store 100 along line 107 via an interface unit 102.

The card 5 is shown schematically in great r detail in Figure 4. Typically, each card is of rectangular shape being about 10 cm by 7 cm and is of rigid plastics or plastics laminated paper material. One edge of the card 5 has two locating notches 70 which engage with cooperating projections 71 on the tray 50 and serve to ensure that the card is correctly positioned on the tray. The upper surface 72 of the card 5 may have written matter giving details of the charts with which the card is associated, the date of issue of the card, operation and handling instructions, advertising matter or so on. The lower surface 73 has a layer 74 of a dispersed magnetic material such as an iron oxide or chromium oxide which may cover the entire surface or, as shown in Figure 4, be separated from the edge of the card by a margin 75 by which the card 5 is supported on the ledge 52. The layer 74 is preferably coated with a protective plastics film sufficiently thin that reading of the card 5 is substantially unimpaired. The layer 74 is divided into sixty four parallel magnetically encoded tracks 76, only five of which 76A to 76E are shown in the drawing, to an enlarged scale. The total area of the tracks being sufficient for storage of about ten thousand bytes, that is, about one hundred and fifty bytes each track. The tracks 76 extended longitudinally of the card 5 and are separated from one another by narrow strips, although it will be appreciated that they could be arranged on the card in various different configurations. Each track 76 has a short magnetically-encoded identifying label 77 at its start which gives details of the information contained in that track. For example, if each card 5 carried data concerning several charts, the label 77 would identify the chart with which the information in that track 76 was concerned. By examining the labels 77 at the left end of each track 76 the correct track can be readily identified. Each track also has a right end marker which serves to identify the end of the track and also to give the location of any additional information associated with the track, such as, for example, if the information in one track is continued in the next track.

The identifying labels 77 at the left of each track are arranged in echelon: the label for one track starting immediately after the end of the label of the preceding track. In this way, after having read the label 77 of one track, for example, track A, and having found that this track does not contain information of interest, the head 60 can be stepped down to read the next label, in track B, without having to move the head back to the left hand end of the track. This reduces the time taken to locate the track of interest and reduces wear on the head drive m chanism by avoiding unnecessary rapid reciprocating movem nts.

The right end markers 78 are als staggered in a similar fashion. This enables the head 60 to b stepped down at the right end of one track to read a successive track which has previously been recorded in the reverse direction (that is, right to left), as sh wn f r track D, without the necessity f reading through the end marker for track D. Indeed, the right hand marker can b omitted from tracks that are recorded in the r verse direction, the end marker being provided at th left hand end of the track, in place of the label. Where information is recorded on two tracks in succession, in this manner, the label at the start of the first track carrying the information also carries instructions giving the location of the next track on which different information is carried so that the head can be displaced by several track widths, thereby avoiding reading unwanted information, or information recorded in the reverse direction. A test track (not shown) is also included on each card for checking the information read off the card. It will be appreciated that various different labelling and marker configurations could be utilised.

The storage member for carrying machine-readable information about the charts could be in various different forms other than magnetically coded cards. For example, magnetic tape cassettes, magnetic discs, punched tape, solid-state memories or optically-encoded material could be used.

With reference again to Figures 1 and 2, the control unit 4 includes a keyboard 80 and display 81. The keyboard 80 is used to start and stop operation of the plotter and to control its various functions. The keyboard 80 is also used to enter any additional information not carried on the card 5. For example, the keyboard 80 may be used to enter the date so that any internally stored tide tables can be consulted automatically. Alternatively, the necessary information from printed tide tables can be entered manually via the keyboard 80. A control may also be provided on the keyboard 80 for displacing the light source 11 to the initial location of the ship, or to a reference location, the coordinates of which are entered by use of the magnetic card 5.

The display 81 of the control unit 4 may be of the alphanumeric kind such as is provided, for example, by a matrix array of light emitting diodes or other electrically-energisable elements. The display may be used to give a representation of the code number or title of the card 5 so that this can be checked against the chart 2. Information supplied by means of the keyboard 80 can also be displayed as a check before entering. Various other information can be displayed, such as, for example, the latitude and longitude of the ship, or warning information associated with the region in which the ship is located.

In operation, a chart 2 is placed in position on the bed 10 of the plotter and its identification number or code is entered by means of the keyboard 80. The card 5 associated with that chart 2 is inserted in the reader 3 — typically one card will be sufficient for several charts — and the reader identifies and reads out the inf rmation associated with the chart in use, writing this into the store 40 for utilisation by the microprocess r and program store 100.

The latitude and longitude of reference co-

ordinates are then displayed n the display 81, and the marker 11 is moved manually, by means of the keyboard 80, to each of these in successi n so that conversions can be made between the chart coordinates and the plotting table coordinates. Information about the present location of the ship is then entered either manually by means of the keyboard 80, if the ship is starting a voyage, or, automatically if the chart 2 is merely being replaced as the ship moves into a new region, the processing unit 30 continuing calculation of navigation whilst the chart is being replaced. The microprocessor and program store 100 continuously searches for the nearest tidal diamond or other flow information in the store 40 and uses this to correct the calculations of the location of the ship.

By storing information about the charts and the areas covered by the charts in a machine-readable form the procedure of setting up a chart is made more rapid and less prone to error from input of false data. More detailed information can be carried in this form than could in practice be entered manually, thereby giving a more accurate estimation of position. The information can also be kept up to date without the need for replacing charts as frequently as has been necessary in the past.

Whilst the system has especial application to chart plotters used in marine craft — because of the need to provide water flow information — it may also have application in automatic map display in aircraft and land vehicles.

Claims

1. Chart plotting system including marker means that is moveable relative to a chart such as to represent location, wherein the said plotting system includes reader means that is arranged to read information represented in machine-readable form concerning said chart, and, or alternatively, the region represented by said chart, such that operation of said system is dependent on said information.

2. Chart plotting system according to Claim 1, wherein said reader means is arranged to read information that is magnetically encoded.

3. Chart plotting system according to Claim 1 or 2, wherein said reader means is arranged to read information carried by a data-storage member separate from said chart.

4. Chart plotting system according to Claim 3, wherein said data-storag member is of card shape.

5. Chart plotting system according to any one of the preceding claims, including a data-storage member having a plurality substantially parallel elongate tracks containing information in machine-readable form, wherein each of some at least of said tracks includes a portion containing information regarding the contents of the remainder of said track, wherein said portions are located at the start of information in said respective tracks, and wherein each said portion is displaced along the length of its respective track relative to an adjacent one of said portions in the direction of reading of said track such that said portions can be read one after the other by changing tracks and without displacement parallel to the tracks in the opposite direction.

6. Chart plotting system according to any one of the preceding claims, wherein said reader means is arranged for displacement relative to a data-storage member carrying information in machine-readable form.

7. Chart plotting system according to any one of the preceding claims, wherein said marker means includes a light source that is arranged to project a light image on the rear of said chart.

8. Chart plotting system according to any one of the preceding claims including a store that is arranged to receive information read out by said reader means.

9. Chart plotting system according to Claim 8, wherein said store is addressed in accordance with calculated position derived by dead-reckoning techniques, and wherein information read from said store is used to modify said calculated position to produce a more accurate estimated position.

10. Chart plotting system according to any one of the preceding claims including means for manually entering information.

11. Chart plotting system according to any one of the preceding claims including an electrical display unit.

12. Chart plotting system substantially as hereinbefore described with reference to the accompanying drawings.

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